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PROGRAM MANAGEMENT COURSE INDIVIDUAL STUDY PROGRAM

LIFE CYCLE COST REDUCTION TECHNIQUES
ASSOCIATED WITH ADVANCED MEDIUM
STOL TRANSPORT (AMST)

STUDY PROJECT REPORT
PMC 77-1

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LIFE CYCLE COST REDUCTION

TECHNIQUES ASSOCIATED WITH THE

ADVANCED MEDIUM STOL TRANSPORT

Individual Study Program

Study Project Report

Prepared as a Formal Report

Defense Systems Management College

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by

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: LIFE CYCLE COST REDUCTION TECHNIQUES ASSOCIATED WITH ADVANCED MEDIUM STOL TRANSPORT (AMST)

STUDY PROJECT GOALS:

To discuss methods used to reduce design to cost (DTC) goals for AMST.
To discuss methods used to reduce life cycle cost (LCC) for AMST.
To discuss Design to Life Cycle Cost Concept for AMST.

STUDY REPORT ABSTRACT:

The report considers what factors have to be conceived, developed, and evaluated in designing a transport aircraft system for introduction in the 1980's. The basic considerations are cost and the attempts made to reduce cost throughout the life cycle of the system. AMST, currently in the validation phase of its life cycle, is evaluated. The parameters considered for cost reduction are range/payload, cargo compartment size, operational field length, engine availability, and crew size. These tradeoffs are considered in arriving at a DTC goal The LCC reduction possibilities are considered separately. The new concept of design to life cycle cost (DTLCC) is evaluated as a combination of DTC goals and LCC goals. The Cost Analysis Cost Estimating (CACE) model is used as the evaluator of operating and support costs for the DTLCC plan. The results proved to be an overview of concepts versus hard facts because of the sensitive nature resulting from the upcoming source selection.

Subject Descriptors: Advanced Medium STOL Aircraft, Design to Cost, Life Cycle Cost, Design to Life Cycle Cost, U. S. Air Force Aircraft System.

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David R. Forville, Major, USA	PMC 77-1	May 1977

EXECUTIVE SUMMARY

INTRODUCTION

The acquisition of a new system into the active inventory is an ordeal unparalleled in the management arena. The development and acquisition of the Advanced Medium STOL Transport (AMST) are proving to be no exception to the rule.

PURPOSE

The purpose of this study is to identify the principal issues associated with the design to cost (DTC) and life cycle cost (LCC) in developing the AMST. These two issues are then examined in relation to a new concept termed design to life cycle cost (DTLCC).

METHODOLOGY

The study is initiated with a brief recap of the AMST development; it is geared toward deriving the major tradeoff criteria used to arrive at DTC goals. These were expanded into factors considered for overall LCC. The net result is evidenced by the explanation of a DTLCC concept which incorporates both DTC and LCC.

IMPLICATIONS

The lack of hard data prevented the study from accomplishing much more than giving an overview as to how models and estimates are being used with the system. When source selection is completed, relevant data will be available from the program office; and it can be used to measure the effectiveness of the estimates. The following information could be used as lessons learned for future systems of this type.

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DEVELOPMENT OF THE ADVANCED MEDIUM STOL TRANSPORT

The intratheater airlift forces of the United States Air Force were in need of a major renovation. The C-130 transport aircraft had been the backbone of the intratheater airlift force for fifteen years.[1] It played a major part in contingency plans during this fifteen-year period, and it demonstrated superior performance during the years of the Viet Nam conflict. However, as a result of the hard usage of the C-130 fleet, tired airframes and improved technology dictated change. The change already existed in the civilian aviation industry. Technology had proven that modern turbofan-powered transport aircraft answered the need for reduced maintenance and personnel costs with increased cargo carrying capacity.

Other aircraft of the intratheater support category (C-7A and C-123) had suffered the same attrition problems as the C-130. The overall numbers of these aircraft had been cut in half, and the C-130 was the only one still in production to meet military requirements. This realization caused the Air Force to state that it would be unable to adequately support logistics missions of the Army or other users by the 1980's.[2]

The civilian aviation industry had proven the feasibility and worth of jet-powered transports. However, the question of whether or not it could be economically transformed into a military aircraft to be used in an intratheater support mission had not been answered. The primary

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[1]Department of the Air Force, Program Memorandum No. 51, USAF Advanced Medium STOL Transport Prototype, 31 August 1972. p. 1.

[2]Ibid.

capability of short take-off and landing (STOL) had to be retained in an aircraft that was jet powered. The development of the high bypass turbofan engine and the development of aerodynamic processes like the "blown flap" concept allowed the jet transport to retain the STOL capability.[3] This development proved expensive, and the only solution to the expense factor of jet power was the tradeoff of expense for increased cargo carrying capability.

In addition to the efforts made by the civilian aviation industry, the U. S. Air Force was deeply involved in identifying the needs of a new replacement aircraft in the medium airlift categoty. The Tactical Air Command (TAC) was given the mission to develop the concepts involved in the development of the new aircraft in the early 1960's. By 1966, TAC was able to define the characteristics desired of a new transport.[4] Except for the area of propulsion, the desired characteristics of the aircraft were advanced, modern, and far-reaching for that time. The power for the aircraft fell back to C-130 technology with the perceived use of turboprop jet engines rather than more modern pure jet engines. Jet assisted takeoff (JATO) was envisioned to facilitate the short takeoff capability.[5]

The desired traits for a medium transport proposed by TAC in the Qualitative Operational Requiremwnt (QOR) were incorporated into the

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[3] Ibid., p. 2.

[4] Department of the Air Force, Qualitative Operational Requirement for an Improved Medium Tactical Assault Aircraft (TAC QOR 66-1-T), 9 March 1966, p. 2.

[5] Ibid., p. 29.

design of the AMST. Responsiveness to the ground commander's needs was essential. Specific items had to be delivered to specific places at precise times to aid the ground commander in the conduct of his operation. This ability had to include outsized cargo at increased weight to exceed the capabilities of present day medium transports. Timely delivery required an aircraft to have both high cruise speeds and long range capabilities.

Flexibility was also needed in the new system. A fluid battlefield would require an aircraft to be able to adapt quickly to different delivery modes.[6] The loss of an airfield would, perhaps, require fast change capacity from airland operations to airdrop operations. In addition, flexibility would include the ability to operate in a counterinsurgency action, as well as a limited or general war.[7]

The capacity for direct delivery of cargo was a vital trait requirement for the aircraft.[8] This would include a maximum intratheater range capability to allow nonstop movement from secure rear area bases to forward supply points. Cost effectiveness would be increased by reducing the number of intermediate supply points required, and it would also reduce the required inventory of stocks.

Tactical operations in a hostile environment always involve the survivability of an aircraft.[9] How the aircraft is employed will determine

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[6] Ibid., p. 2.

[7] Ibid.

[8] Ibid., p. 3.

[9] Ibid.

how long it can survive. Minimum exposure to enemy fire is paramount in survivability. Experience indicates flying low-level profiles and frequently alternating routes are two methods of decreasing attrition rates.[10] The addition of armor plating to crew compartments and to vital components was also considered; however, the tradeoff is always cargo reduction.

The combination of civilian technology and military need evolved into program objectives for the AMST. The objectives are outlined as follows:

A. Design, fabricate, and evaluate prototypes of an operationally suitable transport aircraft which will demonstrate new technology and which, with minimal additional engineering development, could provide a medium sized (C-130 class) turbofan STOL transport.

B. Provide a low cost development option for modernization of the tactical airlift force.

C. Obtain visibility on costs and operational factors associated with short field performance.

D. Define STOL operational rules, safety rules, and related design criteria.

E. Define engine and airframe characteristics which could substantially reduce maintenance support requirements.[11]

Two contractors originally built the AMST prototypes (McDonnell-Douglas and Boeing).[12] Lockheed entered the race later with a stretch version of the C-130. The Lockheed prototype added one hundred inches to the fuselage which allowed increased cargo capacity of one 463L

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[10] Ibid.

[11] Program Memorandum No. 51., p. 3.

[12] Ibid.

pallet.[13] The capability for air-to-air refueling was added which extended the ferry range of the C-130 to 8,400 miles.[14]

McDonnell-Douglas and Boeing developed AMST around the design and performance goals specified in the Tactical Air Command's Required Operational Capability (ROC) #52-69. The goals required that the aircraft have the capability of operating out of a two thousand foot landing zone with a fourteen ton payload.[15] It should have the normal cruise speed of a turbofan transport aircraft.[16] A four hundred nautical mile (nm) radius of action should be achieved using internal fuel.[17] Integral ramp loading will accommodate truck bed heights, and the landing gear is capable of operations from unimproved landing zones.[18] The cargo capacity must be at least six 463L pallets and sixteen to twenty combat loaded troops, and it must be able to haul all the cargo loads now transported by the C-130.[19]

CAPABILITIES OF AMST

The AMST was developed to incorporate two major capabilities -- increased cargo carrying capacity and retention of STOL characteristics. The tradeoff between these two characteristics generally results in an

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[13] Army Times, 2 February 1976, p. 40, col. 5.

[14] Ibid.

[15] Program Memorandum No. 51, op. cit., p. 5.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] Ibid.

increased cargo carrying capability and reduction of STOL characteristics. The tradeoff could also result in an airframe that demonstrated neither one to any satisfactory degree. However, the designers of AMST applied advanced STOL concepts of "powered lift systems."[20] This gave the aircraft increased wing lift over conventional types which results in shorter takeoff distance with regard to speed (90-100 knots) and slower landing speed (85-90 knots) without undesirable low wing loading.[21] In addition, powered lift systems effectively allowed the thrust to weight ratio to double that of conventional transports. The end result of this was increased cargo loads on and off shorter fields.

The cargo envelope dimension of the AMST is 40% greater than its C-130 counterpart.[22] With a payload of between 28,000 and 53,000 pounds, the AMST resupply capability is substantial. The aircraft was so designed to allow it to transport 88% of a Separate Mechanized Infantry Brigade's equipment.[23] This compares to 63% capability in a C-130.[24] In addition, most equipment can be loaded aboard the AMST in a combat configuration. Considerable size reduction is required before loading can be accomplished in the C-130.

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[20] Ibid., p. 10.

[21] Ibid.

[22] A Concept for U. S. Army Tactical Mobility, The Boeing Advanced Medium STOL Transport, p. 71.

[23] Meyer, Edward E. Review of AMST Design Requirements for Transport of Army Cargo, Newport News, Virginia, December 1974, p. 12.

[24] Ibid.

Although STOL parameters required only a 28,000 pound maximum load capacity, the designed maximum load of 53,000 pounds for the AMST had advantages. Using conventional takeoff and landing (CTOL) procedures and facilities, the AMST cargo hauling capability is increased by sixty-one pieces of equipment which cannot be loaded aboard a C-130.[25]

The need to establish the air line of communication (ALOC) serves only to reinforce the additional weight carrying capacity of the aircraft. The ALOC offers the ground commander flexibility of maneuver and simplicity of operation. This fact is evident from Viet Nam field reports which indicated that 50% of the daily resupply requirements for the 1st Air Cavalry Division was accomplished using an ALOC.[26] This study also indicated that Army ground forces will become even more dependent on air resupply in the future. There are many areas in the world where surface modes of transportation are greatly restricted. Road nets are low capacity, vulnerable to enemy action, subject to climate extremes, or too slow to allow timely delivery of critical supplies.

The AMST was designed to accommodate the Army's equipment for the 1980's. Current configuration will allow loading of the Army's "Big Five" (MICV, UTTAS, AAH/TOW, XM-1, SAM-D) as soon as they are introduced to the field.[27] Equipment planned beyond 1985 (HLH, GOER, ROLAND/CROTALE) can also be air transported aboard AMST as currently configured.[28]

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[25] Ibid., p. 17.

[26] TAC QOR 66-1-T., p. 14.

[27] A Concept for U. S. Army Tactical Mobility, p. 66.

[28] Ibid.

All weather capability was considered in development of the AMST. Weather could be the deciding factor in mission accomplishment, delivery mode, tactics, allowable cargo load, or fuel requirements. All weather capability of the AMST offers an advantage. The enemy considers bad weather as a tactical advantage, and they would plan to use this advantage as illustrated in Southeast Asia during the rainy season. The AMST with its navigational ability in adverse weather coupled with STOL capability, would reduce the enemy advantage to exploit the situation. Austere base resupply with reasonable security against enemy action would allow reasonable success of this mission. However, weather conditions could easily exceed marginal visual navigation as well as instrument navigation. Unless the forward base airfield has instrument landing facilities, the advantage would shift back to the enemy. Linkup with other modes of transportation (motor or helicopter) would be required to move supplies beyond the division instrumented airfield.

Methods of cargo delivery vary for the AMST. The tactical situation, weather, terrain, drop zone size or ground support available will dictate the mode of delivery. Airland delivery of supplies into airfields of less than 2,000 feet was one of the primary considerations in the design of the aircraft. If at all possible, airland delivery is the preferred method of delivery.

Air drop or extraction are two methods to be considered if airland is impossible.[29] The use of either method of delivery eliminates a

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[29]TAC QOR 66-1-T., op.cit., p. 7.

landing requirement. However, there are tradeoffs to consider regarding the condition of cargo on arrival. In addition, there is a possibility of cargo falling into enemy hands--cancelling all benefits of the resupply mission.

DESIGN TO ›ST FOR AMST

On 24 January, 1972, a Request for Proposal (RFP) for the Air Force AMST prototype was issued to industry by the Aeronautical Systems Division of the Air Force Systems Command. At the time the RFP was issued the Secretary of Defense specified that the design to cost (DTC) concept would be applied to the AMST program.

The application of DTC to the AMST program started early in the requirements process. Production costs, key support cost factors, and quantity relationships had to be derived. These were compared with available resources and iterated as primary parameters during the formulation of minimum essential performance requirements of AMST. This type of action was used to iritially establish cost goals which were validated and refined for use as primary design parameters. At this stage the design to cost parameters were equal to any performance requirements used during Full Scale Engineering Development (FSED).

Tradeoffs became a way of life for AMST, and they were used extensively during conceptual and early validation phases. The tradeoffs occurred in the areas of range/payload, cargo compartment size, operating field length, and engine availability.

The DTC goal for AMST stressed cost over performance--which was a new approach for the involved contractors for DoD systems. Boeing and

Douglas had to reevaluate their initial estimates because previous acquisition programs by the government had not stressed the cost aspect so much. This was particularly true when cost was weighed against performance. The results of reevaluation for both contractors indicated that the DTC goal for AMST was achievable.

In order for either contractor to reach the stated goal, another important characteristic of DTC was utilized. Tradeoff decision thresholds were established and continually tested for validity. Management in both contractors' plants as well as the AMST program office were required to tradeoff various performance requirements for cost.

The use of an unswept wing is an example of cost savings. The unswept wing is currently used on the C-130 aircraft. This contrasts to the swept wing used on aircraft like the B-52. Basically, it is less costly (exact cost unavailable) to produce a straight wing than a swept wing. Performance would not be affected appreciably because of the implementation of the supercritical wing design into AMST. The loss in cruise speed using the straight wing was counteracted by using within the state of the art supercritical wing design. In addition, the wing tradeoff did not affect STOL performance, stability, or control.

The cargo compartment was another area for tradeoff consideration. The original RFP specified size (12' x 12' x 55') was designed into a cylindrical section for as much length as possible for ease of manufacture. The design which resulted actually reduced the height and width of the box by almost one foot.

The selection of engines by both contractors was also a cost to per-

formance tradeoff. The use of developed engines proved to have cost savings by eliminating the research costs associated with new engines with increased performance capability. Again, exact cost savings was not available.

Boeing's approach to cost savings under the DTC concept, although not unique, was very practical. Boeing depended upon its ability to fix the cost of each component, assembly, and subassembly as early as possible. In order to do this, strict attention to detail was required early in the design stage, and this attitude had to be maintained throughout the course of development. The key to success was Boeing's ability to apply a cost to elements at the lower levels of the work breakdown structure. This allowed quantification of early design decisions. The use of this technique allowed Boeing to eliminate many of the known/unknowns in the system.

Standardization was used by both Douglas and Boeing in arriving at the design to cost bogey. Parts common to 727, 737, 747, and DC9 aircraft were used as much as possible in the prototype development of AMST. The use of learning curves, design experience, and marketing techniques from other aircraft designs can also be termed standardized methods when applied to AMST.

When DTC was applied to AMST, it was in the form of prototype contracts only. There were no promises made by the Air Force that AMST would go beyond prototyping. Regardless of this, both contractors developed prototypes in a very competitive atmosphere. Competition between contractors is a key feature in DTC. Even though the AMST initially was not envisioned to go beyond prototyping, both contractors could sense the

possibilities of following engineering development and production contracts.

The contractors were chosen through an evaluation process which considered criteria such as contractor capability, technical approach--including design and performance goals, prototype development effort, and costs.[30]

Douglas was awarded a cost sharing contract, and Boeing received a cost plus fixed fee (CPFF) contract. The purpose of using these contracts from the government's point of view is to get the contractors to invest their capital as well as the government's. In doing so, the contractors would be incentivized to drive costs down in order to make bigger profits. Achievement of the DTC goal will require a stringent costing effort in order to realize a profit during prototyping.

A production cost goal of $7.2 to $7.8 million was initially established, and it was later revised downward to $5.0 million in FY 1972 dollars.[31] This cost goal was described as the average flyaway cost in FY 1972 dollars for the 300th production model, and it was based on a reasonably paced production schedule. In order to achieve the lowered cost goal of $5.0 million, tradeoffs mentioned above were considered, and the RFP was modified. The operating radius was reduced from 500 to 400 nautical miles, and the STOL payload when operating from austere airfields

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[30] Stephen A. Hamer, Problems Encountered in Implementing Design to A Cost in Major Air Force Weapon System Acquisition Programs (Wright Patterson Air Force Base, Ohio), October 1973, p. 59.

[31] Department of the Air Force, Cover Sheet No. 1 for Program Memorandum No. 51 Advanced Medium STOL Transport, 30 May 1975, p. 6.

was reduced from 30,000 to 27,000 pounds.

The constraints posed in the RFP resulted in both contractors not meeting the $5.0 million goal. They were redirected to attempt to reduce costs by conducting performance and configuration analysis. The results of this analysis produced cost estimates of $5.1 to $6.1 million.[32]

The Assistant Secretary of Defense office conducted its own analysis of design cost for AMST. The results of the analysis fell within range of the second contractor's analysis. The project management design cost factor was then set between $5.1 to $6.1 million for the 300th production model based on FY 1972 dollars.

One of the fallacies of DTC has been demonstrated above. What started out as a supposedly sound DTC figure in the RFP band of $7.2 to $7.8 million was adjusted downward to $5.0 million to instill design creativity. Contractors responded with their own DTC figures which were unacceptable, and the final figure was a compromise. The ramifications of this procedure could easily imply inferior systems whose overall value may be inadequate. The goal is to obtain reliable and capable systems, but the object is not to sacrifice quality in obtaining DTC goals.

The implementation of the DTC concept with DoD projects is done at two specific levels. The first level, described above, results in a forecast of what the unit "flyaway" costs are going to be at a certain level of production.

Level two of the DTC matrix is called the "average unit flyaway"

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[32]Program Memorandum No. 51, op. cit., p. 6.

cost which equates to the total flyaway costs divided by total units. Both levels fail to consider anything but production costs in computing a final DTC figure.

The end result of the DTC for the AMST is still in the future. However, computer simulation models have indicated that production costs will run as high as twenty-five percent over estimated cost goals.[33]

LIFE CYCLE COST CONCEPT OF AMST

Design to cost incorporates only part of the costs associated with the introduction of a new system like AMST. Essentially DTC takes AMST through the production phase which completes the total acquisition phase.

Operations and support (O&S) costs of the system or the second half of the Life Cycle Cost (LCC) equation follows acquisition of AMST. Over the past few years, DoD's flexibility to allocate resources between competing demands has been reduced because of shrinking dollars. The O&S costs have continued to rise until they now consume about 30 percent of the total defense budget. If manpower reductions to support equipment had not been made, O&S costs could amount to 50 percent of the defense budget.

The realization that O&S costs were increasing, and there was a lack of stored data dealing with these costs dictated the use of models and associated methodology in the application of LCC to AMST.[34] Models were able to trace program process through advanced and full-scale development.

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[33]Department of the Air Force, Advanced STOL Transport (Medium) Study Costs and Schedules, August 1972, p. 71.

[34]Department of the Air Force, Life Cycle Cost (LCC) Plan for the AMST Program, 11 August 1975, para. 4.2.

Some cost (production and support) performance tradeoff flexibility was needed to permit development of the best performing system within the cost constraints. Significant changes from previously applied methodology and practice include the use of end item performance goals or specifications rather than detailed technical specifications for systems, subsystems, and components. Separation of mandatory versus desirable characteristics or characteristics of marginal cost effectiveness have to be accomplished. In addition, feedback of estimated production and support costs have to be furnished to permit early corrective action in trouble areas.

Standardization concepts discussed earlier in DTC can be applied to LCC. These concepts tend to drive down operating and support costs. This is particularly true in the use of value engineering in high cost areas. It is much more cost effective to standardize before production is implemented than after it is completed.

Additional considerations as part of LCC are as follows:

(1) Contracting to permit maximum tradeoff flexibility between cost, performance, and schedule.
(2) Sufficient time to iterate design to reduce future costs.
(3) Maintenance of competition as long as economically justifiable.
(4) Use of contract incentives during full-scale development which drive the contractor toward lower production and/or support costs.
(5) Consideration of warranties for early use during the production phase.
(6) Periodic top management review to determine whether or not to continue, alter, or cancel the program.[35]

Life cycle cost goals for AMST will be established. These will include

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[35] Assistant Secretary of Defense for Installations and Logistics, Cost to Produce Handbook, 26 October 1973, p. 4.

independent evaluation and cost analysis in the functional areas of propulsion, avionics, instruments, and landing gear.[36] An attempt will be made to establish LCC goals in each of these areas and to allocate those goals through a work breakdown structure (WBS) established by each contractor. The contractor can establish costs at the work package level of the WBS. These costs can then be accumulated to arrive at a LCC. The exact purpose of this methodology will be to quantify LCC objectives at a level where contractors and Air Force personnel can recognize and take appropriate action to obtain maximum benefit of savings.

Funding allocated to testing various propulsion systems was $250 million. The purpose of the study was to test the tradeoffs to reduce total LCC. These trades include changes to engines, reduced power takeoffs, maintenance concepts, data, and authorized government equipment.

Avionics testing was funded for $100 million. This study was extensive and covered five main efforts to determine the most cost effective LCC. The study lasted 14 months, and it measured the areas of performance requirements, system parameters, avionics configurations, research and maintenance analysis, and life cycle costs associated with each area of study.

ACTUAL FUNDING AUTHORIZED FOR AMST

The AMST is currently in the validation phase of the Life Cycle System Management Model. Funding has been authorized through FY 1976 at $85.0 million. Total expenditure through validation is expected to be

[36]Life Cycle Cost (LCC) Plan for the AMST Program, op. cit., para. 3.2.2.

$229.1 million.[37] A congressional reduction in FY 1975 funds caused a contract slippage of approximately a year. This further required contract renegotiation with the associated add on costs of the revised contract amounting to $29.1 million.

The funding picture for the period FY 1972 through FY 1977 is attached (Tables I and II) and it is expressed in then year dollars. In addition, the ten year life cycle costs of alternative force structures is attached (Table III). It shows LCC between the AMST and the C-130. As already pointed out, a clean split in force structure between the two aircraft will not be cost effective. The ultimate force will be a combination of AMST and C-130 aircraft.

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[37] Cover Sheet No. 1 for Program Memorandum No. 51, op. cit., p. 6.

TABLE I

ORIGINAL CONTRACT

($ in Millions)

	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	Total
Boeing	2.5	14.0	29.5	39.4	10.8	0	96.2
Douglas	2.5	9.0	37.2	30.3	7.1	0	86.1
Other Costs	0	2.0	0.5	6.0	4.9	4.3	17.7
Total	5.0	25.0	67.2	75.5	22.8	4.3	200.0

TABLE II

RENEGOTIATED CONTRACT

($ in Millions)

	FY 72	FY 73	FY 74	FY 75	FY 76	FY 7T	FY 77	Total
Boeing	2.5	13.0	12.0	27.5	41.7	3.0	6.2	105.9
Douglas	2.5	10.9	12.0	27.5	58.7	3.0	5.7	100.3
Other Costs	0	1.1	1.0	0.8	4.6	5.4	10.0	22.9
Total	5.0	25.0	25.0	55.8	85.0	11.4	21.9	229.1

TABLE III

AIRCRAFT NEEDED AND LIFE CYCLE COSTS

FOR ALTERNATIVE FORCES

Alternative Force	Type Craft	No. of UE A/C Needed	Ten Year LCC Per UE	Total 10 Yr. Cost
			Invest/O&M/Total	
Force A	C-130E	11	1.0/6.5/7.5M	384.5 M
	C-130E*	20	8.5/6.6/15.1M	
Force B	Narrow-Bodied AMST(SS'1)	14	13.5/7.3/20.8M	291.2 M
Force C	Wide-Bodied AMST(47'L)	13	14.0/7.4/21.4M	278.2 M

*This represents an updated version of the C-130

DESIGN TO LIFE CYCLE COST CONCEPT FOR AMST

The proposed approach to determine LCC for AMST is named the Design To Life Cycle Cost (DTLCC) concept. This will allow all costs associated with minimum engineering development (MED), weapon system costs, other support costs, and operating and support costs to be totaled. In essence, LCC results from the use of DTLCC.

The DTLCC goal is in FY 1977 dollars. It can be stated by the included formula with the terms explained on the following pages.

$$\frac{\text{"MED Costs"}}{277} =$$

$$+ \frac{\text{"Weapon System Costs"}}{277} = \text{Average Weapon Support Costs} =$$

$$+ \frac{\text{"Other Support Costs"}}{277} =$$

$$+ \frac{\text{"Operating and Support Costs for 20 Years of Fleet Operations"}}{277} = \underline{\hspace{3cm}}$$

$$= \text{TOTAL DTLCC GOAL}$$ [38]

Minimum engineering development is a direct carryover from prototyping developed during validation. However, the R & D money spent during validation is considered a sunk cost in DTLCC planning. The results of validation are seriously considered during MED to improve original prototype and to achieve the cost bogey established for MED. The goal established is $522.2 million in FY 1976 baseyear dollars.

The competitive environment remains which forces each contractor to

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[38] "C-14/15 Design to Life Cycle Cost (DTLCC) Plan (Proposed)" (Wright Patterson Air Force Base, Ohio), para. 1.3.

propose plans which are designed to stay within established costs. A Cost Plus Incentive Fee (CPIF) contract is anticipated to be used for MED which will also incentivize cost reduction. Areas for incentives are cost, logistic support, schedule, technical, and general management.

Monitoring the cost track during MED will be accomplished using the Cost/Schedule Control System Criteria (C/SCSC) and related reports. In addition, Program Assessment Review/Command Assessment Review (PAR/CAR) reporting will be utilized.

The award fee is intended to motivate the contractor to follow his plans. It also encourages early contact with the Air Force on any anticipated changes to his plans. At the same time, PAR/CAR and C/SCSC serve as a check on how well the contractor is following his plan.

Weapon system costs (WSC) are the next area for consideration in DTLCC. The costs associated with WSC are those found in DoD 5000.28 in describing average unit flyaway costs. Equal importance is placed on training hardware, peculiar support equipment, data, system project management, and other government costs (printing and supply of essential engineering data).[39]

At this point it is envisioned that the DTLCC goal has been achieved to allow the contractors to propose going to a Fixed Price Incentive Fee (FPIF) contract for three production options of 60 aircraft per production run. This also allows the government to establish a baseline on costs throughout the production of AMST. At the same time it serves notice to

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[39] Ibid., para.4.0.

the contractors that the Air Force is considering all production costs and not just the average unit flyaway costs.[40]

Tracing WSC throughout the production phase will follow closely the methods used during MED. In addition to using C/SCSC, Contract Cost Data Report (CCDR), Cost Performance Report (CPR), Contract Financial Status Report (CFSR), a Contractor Performance and Cost Report will be used to furnish a cost estimate at completion.

Other support costs (OSC) are an integral part of the DTLCC plan. The costs considered under OSC are initial common support equipment, initial spares and repair parts, spare engines, non-production facilities modification, interim contractor support costs, and Type I training.[41] The separate ingredients of OSC will be arrived at through cost estimating methodologies and relationships. By estimating each part of the equation comprising OSC, management can use results as a controlling mechanism to reduce costs.

Contractor support in reducing OSC has been encouraged through both MED and production. Trade studies by contractors will be used during MED which could result in design change. When design decisions occur, definite cost milestones will be established. Progress to meet these milestones will be measured.

While the goal is to minimize each part of OSC, the overall goal is to reduce the major enemy--operating and support (O&S) costs. The objective of close monitoring of OSC is to reduce the initial lay-in of spare parts,

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[40]Ibid., para. 4.0.

[41]Ibid., para. 5.0

engines, common support equipment, and the minimization of any non-production facilities modification. In addition, simplification of design will reduce the training requirement under the direction of Air Training Command.

Operations and support costs have characteristically amounted to almost 50 percent of the LCC costs of a major weapons system. The intent of the AMST DTLCC plan is to reduce that percentage to a more acceptable level.

The value of O&S costs for AMST will be established after source selection. The primary reason for doing this is to allow the selected contractor to reflect his unique aircraft's characteristics. The O&S cost goal established for the DTLCC plan will be total fleet O&S for 20 year aircraft life divided by 277.[42]

What are considered as O&S costs for AMST? They include direct and marginal costs for personnel and material at the base level, depot support, and personnel pipeline costs.

To estimate what O&S will cost for AMST, the Cost Analysis Cost Estimating (CACE) model was selected. The model was modified slightly to reflect specific aspects of the AMST program. Two parameters to be selected to compute these costs are annual squadron and fleet O&S costs. Basically, CACE may be used to develop aircraft squadron annual operating cost estimates when flexibility in the selection of factors or changes to the

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[42]Ibid., para. 6.0.

methodology of the model may be desired.[43]

Data input to be used in the CACE model will be developed by the contractors prior to source selection. The developed information will be amended by the Air Force during source selection. At this point, all model input data will become fixed, and any revisions will be controlled by the program management office.

Like the MED goal, the O&S cost goal also carries incentive fees. The incentives are designed to be able to check the contractor's product once it becomes operational. The first operational readiness evaluation (ORE) will occur during the last phase of the mini-squadron--prior to delivery to the using command. The second ORE will occur about two years after initial operational capability (IOC). It will be conducted under the operational atmosphere of a MAC squadron.

FUND CONSTRAINTS FACING AMST

Continued development of AMST could be postponed indefinitely because of financial constraints imposed by Congress. Department of Defense is currently considering the future of five programs involved with airlift capability. The total sum of these projects if $9.7 billion of which AMST accounts for some $4.5 billion.[44]

The tradeoff with airlift is the modernization of Military Sealift

[43] Department of the Air Force, Regulation 173-10, USAF Cost and Planning Factors(U). February 1975, para. 2-64.

[44] "House Panel Scores 9.7 Billion Dollar Airlift Hodge-Podge," Armed Forces Journal, (July, 1976), p. 15.

Command's cargo fleet. MSC assets have decreased from 100 ships in 1970 to only four ships presently.[45] When 95 percent of all cargo going to Viet Nam went by ship, it is easy to see the justification in switching funds from airlift to sealift.

The AMST position becomes less attractive when the results of recent cost studies are presented. USAF Chief of Staff, General David Jones, indicated that a fleet of 277 AMST's would cost $4,125 billion in FY 1976 dollars.[46] An equal capability buy of C-130 aircraft would require the purchase of 426 new C-130H's at a cost of $3.229 billion.[47] This also considers the use of 298 older C-130's already in service. A combined fleet of AMST and 228 existing C-130's would prove to be more cost effective over a 20 year period than the pure fleet of 724 old and new C-130's. The costs would be $10.5 billion for AMST/C-130 fleet as compared with $13 billion for C-130's alone.[48] Cargo capability is considered equal between the two fleets.

In addition, Air Force Studies and Analysis has completed a comparative analysis of alternate forces for tactical airlift aircraft during the 1980's. The analysis indicates that a six to nine percent cost savings could be realized by modernizing the tactical fleet. This could be done by eliminating the C-7, C-123, and older C-130 aircraft from the Air Reserve Forces and replacing them with the newer C-130's currently in the

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[45] Ibid.

[46] Ibid.

[47] Ibid.

[48] Ibid.

active fleet. The active C-130's would be replaced by AMST's.[49]

SUMMARY

The AMST possesses the capability to be the replacement for existing intratheater airlift aircraft for the 1980's. The application of AMST in a limited strategic role could be demonstrated which lends credence to its introduction into the active fleet.

The Army's support as the primary user of AMST indicates a need to upgrade intratheater airlift capabilities for the same timeframe. Improvements in range, cargo carrying capability, and STOL characteristics at economic cost support the continuation of AMST in the eyes of the Army.

The use of the DTLCC concept appears to contain the basic ingredients of an adequate program managed system. The planned methods under DTLCC to reduce costs over the life cycle of AMST can work if continually monitored and challenged by the contractor and the Air Force.

CONCLUSIONS

The AMST is currently scheduled for DSARC II in September 1977. The cost data used in various models for LCC are being kept close to home within the program office and/or the two contractors' offices. This is understandable considering the sensitive nature associated with source selection. Considering a satisfactory result from DSARC II, the AMST projected LCC would be an excellent area for additional reserach and evaluation from a lessons learned standpoint.

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[49] Department of the Army, Required Operational Capability (ROC) for an Advanced Medium STOL Transport (AMST), 5 January 1976, p. 4.

Another area which could not be fully researched was the extent of different types of cost estimating relationships used to determine specific tradeoffs. Tradeoffs in range/payload, cargo compartment size, operational field length, and type engines available are preliminary in nature and subject to change. Final results will vary based on configuration, development concept, and logistics support concept. Additional estimates regarding contractors' proposals, subsequent negotiation, and final selection of contractor will be included.

Finally, what will happen to AMST regarding total DoD budgeting in relationship to all Air Force projects? Theoretical projections do not promise smooth sailing for AMST because of the ever-dwindling amount of dollars, as well as the ranking of AMST in relation to systems such as B-1 and F-15/F-16.

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